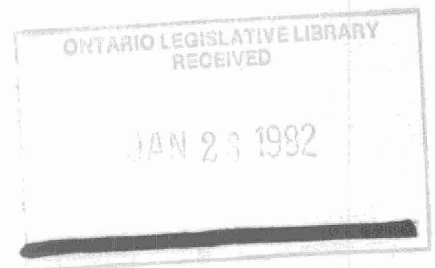


~~ENV ROLD~~

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PHYTOTOXICOLOGY INVESTIGATIONS

in the vicinity of the

SUNSHINE RAIL SIDING

May-August, 1979

D. J. Racette
Plant Pathologist

H. D. Griffin
Chief, Air Quality Assessment



TECHNICAL SUPPORT SECTION
NORTHWESTERN REGION
ONTARIO MINISTRY OF THE ENVIRONMENT

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INTRODUCTION

Investigations conducted by the Ontario Ministry of the Environment in 1977 and 1978 revealed the presence of elevated concentrations of cobalt, copper, and nickel in snow, vegetation, soil and experimentally exposed moss near the CPR rail siding at Sunshine, about 35 km (kilometres) west of Thunder Bay (1, 2, 3). The siding serves as a transfer point for base metal ore concentrates hauled by road from the Inco Metals Company Limited Shebandowan Mine and shipped by rail from Sunshine to the company's smelter at Copper Cliff.

To determine background levels of metals in the air, a moss exposure survey was undertaken during a period when the siding was temporarily not in use for ore trans-shipment. Also, a limited bioassay experiment was performed with contaminated soil from the rail siding in an attempt to demonstrate the effects, on vegetation, of heavy metals in soil.

MOSS EXPOSURE EXPERIMENT

At the rail siding, bags of Sphagnum moss were exposed from May 5 to June 5, 1979, at 5 sites (Figure 1) plus two control locations remote from the survey area. A description of the moss preparation and processing procedure appears in our 1979 report (3) on an earlier study at Sunshine. Each sample was dried for 30 to 40 hours at 80°C, then ground in a "Wiley" mill equipped with a 1-mm (millimetre) pore-size screen. A 1-g portion of each sample was reduced to ash at high temperature. The ash was digested in mixed acids, and the extract obtained was analysed by atomic absorption spectrophotometry for cobalt, copper, iron, and nickel.

Moss analysis results, presented in Table 1, indicated that levels of cobalt, copper, iron, and nickel were much lower than those found in 1978, when the rail siding was in continuous use.

However, concentrations of cobalt, copper, and nickel were still slightly above normal background values.

BIOASSAY STUDY

On May 8, 1979, approximately 80 litres of soil (0-15 cm) from each of two sites, one located at site 2 (Figure 1) and the other at a point remote from the study area, were collected in separate large plastic containers and taken to the Ministry's Thunder Bay laboratory. The soils, both sandy clays, were spread on paper and air-dried for about 7 days, then screened through a coarse sieve to remove stones and plant material. Each of the two soil types was divided into eight, 10-litre aliquots, and each aliquot (16 in all) was placed in a separate flat. Each flat received an equal addition of nitrogen, potassium and phosphorus fertilizer prior to commencement of the experiment on June 6, 1979. Five corn (*Zea mays*) seeds were planted in each flat, and the flats set out on the roof of the Ministry's Thunder Bay laboratory. Germination rates were determined 3 weeks after sowing. Flats were watered and weeded as required. At the end of the experiment on August 16, 1979, plant heights and above-ground weights were measured and injury symptoms were recorded. Soil and plant material were subsequently analyzed by atomic absorption spectrophotometry for cobalt, copper, iron, and nickel. Soil pH was also determined.

The experimental data for plant growth and metal analysis are presented in Table 2. Corn germination rates were 45 percent for the metal contaminated soil and 63 percent for the control soil. After 65 days, foliage of corn plants growing in contaminated soil showed trace to light terminal necrosis in addition to significantly reduced growth in comparison to plants growing in the control soil. Average metal concentrations ranged from 2 to 8 times higher in contaminated than in uncontaminated soil, and from 2 to 17 times higher in test plants grown in Sunshine soil than in corn plants in soil from the control site. Because

of the large variability in some of the data and the small number of replicates, statistically significant differences could not be demonstrated between average metal levels in Sunshine and control soil, or between average weights of plant harvested for the two soils. The metal levels in the rail siding soil were fairly typical of those reported in an earlier study (3).

DISCUSSION

The data from the moss exposure experiment in 1979 confirmed the findings from snow samples collected earlier that year (4), which showed a significant reduction in levels of nickel, copper, and cobalt deposition at Sunshine rail siding during a period when ore trans-shipment operations were temporarily suspended. Both studies showed that there was some residual contamination, probably due to wind erosion of contaminated soil.

The bioassay investigation provided preliminary evidence that contaminated soil from the vicinity of the siding could adversely affect the germination, growth, and appearance of experimental corn plants. It is very possible that Sunshine soils would also be toxic to local indigenous vegetation, but this hypothesis would require appropriate testing for confirmation. Soils containing elevated concentrations of heavy metals in the vicinity of base metal mines throughout the region might also be usefully subjected to similar examination. However, due to current constraints on Ministry resources, work of this nature cannot be undertaken at present. An abatement program has been discussed with CPR. The timing of the implementation of this program is tentatively set for 1982.

REFERENCES

1. Racette, D. J. 1977. Snow sampling study, Sunshine rail siding. February, 1977. Ontario Ministry of the Environment.
2. Griffin, H. D. and D. J. Racette. 1978. Snow sampling study, Sunshine rail siding. January, 1978. Ontario Ministry of the Environment.
3. Racette, D. J. and H. D. Griffin. 1979. Phytotoxicology investigation, Sunshine rail siding, May 31 to August 15, 1978. Ontario Ministry of the Environment.
4. Racette, D. J. and H. D. Griffin. 1979. Snow sampling survey in the vicinity of Sunshine rail siding, January, 1979. Ontario Ministry of the Environment.

TABLE 1. Levels of cobalt, copper, iron, and nickel ($\mu\text{g/g}$, dry weight) in moss exposed at Sunshine from May 31 to July 5, 1978 and from May 5 to June 5, 1979.

Site	Cobalt		Copper		Iron		Nickel	
	1978	1979	1978	1979	1978	1979	1978	1979
2	5	2	86	16	2400	2500	150	24
3	24	2	360	8	4100	2000	600	12
5	6	2	100	8	2400	1600	170	7
6	2	2	66	9	2100	1500	42	17
8	9	1	150	6	3500	1400	280	13
Exposed controls	1	1	5	4	1700	1500	5	2
Unexposed controls	1	1	6	4	1500	1900	2	4

TABLE 2. Height, and above-ground dry weight of corn plants, and heavy metal levels ($\mu\text{g/g}$, dry weight) in corn and soil (0-15 cm), Sunshine, 1979 (mean of eight replicates per treatment).

	Corn					Soil (0-15 cm)			
	Co	Cu	Ni	Weight (g)	Height (cm)	Co	Cu	Ni	pH
Sunshine	2	25	67	0.58 ^a	19	31 ^a	250 ^a	250 ^a	5.9
Sd	1	10	26	<1	4	23	202	190	<1
Control	1	8	4	11.93 ^a	40	17 ^a	35 ^a	30 ^a	5.0
Sd	<1	4	3	17	21	1	6	2	<1
Normal background	<10	<30	<30			<25	<100	<100	

Sd = standard deviation

^a within columns, means followed by the same letter were not statistically significant at $P < 0.05$ according to analysis of variance.

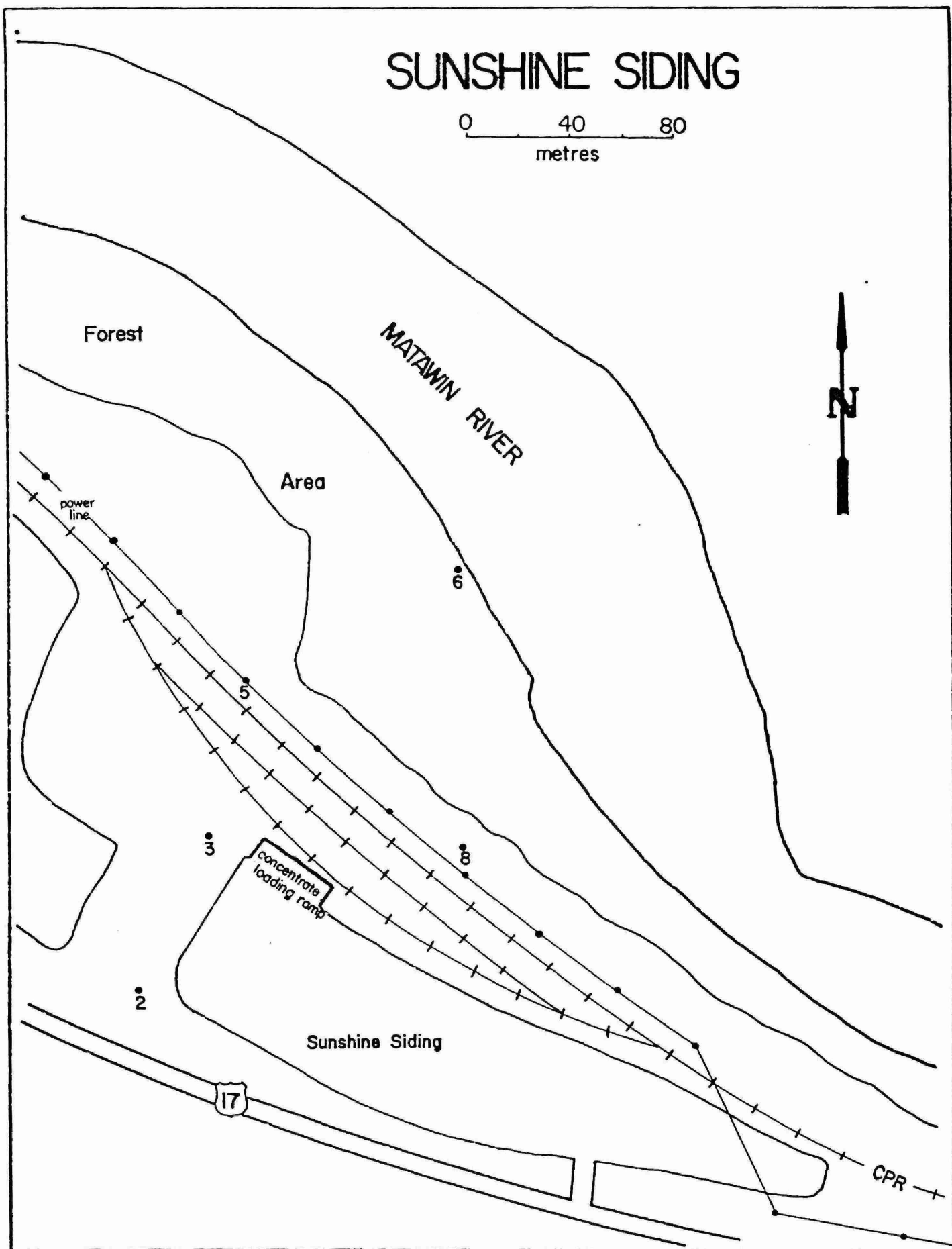


Figure 1. Moss bag exposure sites, May, 1979.

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 Manager, Industrial Abatement.
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 Regions 5 & 6, Industrial Approvals Section

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